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ENVIRONMENTAL IMPACT STATEMENT

/FOR/

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LEWIS RESEARCH CENTER

CLEVELAND, OHIO



(NASA-TM-X-68557) ENVIRONMENTAL IMPACT
STATEMENT FOR NATIONAL AERONAUTICS AND
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ENVIRONMENTAL IMPACT STATEMENT

Lewis Research Center
National Aeronautics and Space Administration
Cleveland, Ohio

SUMMARY

This is an institutional environmental impact statement for the NASA-Lewis Research Center (LeRC) operation, in the State of Ohio: Cleveland Site, 350 acres, located in Cuyahoga County and Plum Brook Site, 8000 acres, located in Erie County. The LeRC is NASA's lead center for research and development of propulsion and space electric power generation systems and is also responsible for operation and management of NASA's medium sized launch vehicles.

Operations at LeRC have a negligible adverse effect on the environment. Operations are monitored and controlled to minimize and to maintain below Federal, State and Local standards all air and water emissions and noise. Several areas of work at LeRC contribute to the long-term improvement of the environment: jet aircraft noise and emission reduction; airport, urban, lake and upper atmosphere pollutant studies; and low-pollutant automotive engine development.

There are no appropriate alternatives to the operation of the LeRC at the present location, since there is no known reasons why the quality of the environment locally, statewide, or nationally would improve if the facilities and operations were moved to another location. Further, the duplication of the facilities elsewhere would require the expenditure of \$340,000,000 and result in several years loss of operation.

No adverse comment has been received from Federal, State or Local agencies or from private organizations or individuals on the substantive aspects of the draft impact statement.

Draft statement made available March 1, 1971 and final statement made available in July 1971 to Council on Environmental Quality and the public.

I. DESCRIPTION

A. CENTER MISSION

The Lewis Research Center is NASA's lead center for research and development of propulsion and space electric power generation systems. It is also responsible for the operation and management of NASA's medium-sized launch vehicles.

Currently the Lewis Center devotes about one-half of its work to space-related subjects -- rockets, electric power, launch vehicles and spacecraft. About one-third is identified with aeronautics. The remainder is widely applicable basic work such as materials research, fluid mechanics and electrophysics.

Research on air breathing engines is focused on systems for V/STOL, subsonic, supersonic and hypersonic aircraft. Work ranges from exploratory investigations on components to complete engine testing. Lewis is also responsible for development of the "Quiet Engine" for subsonic transports and is developing low cost turbine engines for civilian and military use.

Rocket research and development encompasses chemical, nuclear and electric engines. In the chemical field Lewis pioneered the technology of high energy liquid hydrogen-liquid oxygen rocket engines. It is continuing to expand man's knowledge in this field looking at even higher energy combinations. In the nuclear field, Lewis has worked in cooperation with the Space Nuclear Systems Office (SNSO) on various aspects of the NERVA rocket engine. It is also conducting research on various other types of nuclear rockets including the gas core reactor system.

The Center has a broad program on electric power generation for space use which includes research on batteries, fuel cells, solar cells and turbo-generator systems. Advanced concepts such as thermionic diodes and magnetohydrodynamic systems are also under study.

Responsibility for NASA's medium class launch vehicles came to the Center late in 1962. Since that time Lewis completed the development of the Atlas-Centaur which successfully launched seven Surveyor spacecraft to the moon, Applications Technology Satellites and Orbiting Astronomical Observatories. It also has been used to send probes to Mars. Improvements are presently underway including mating with the Titan family of boosters.

More than 30 Agena launches have taken place under Lewis direction including the Lunar Orbiter and Ranger series of spacecraft.

Lewis is widely known for its research in refractory metals, super-alloys and metal fiber composites. It is also active in the fields of liquid metal corrosion and polymers. New concepts have added considerably to understanding of fracture mechanics and the determination of long term properties of materials through short term tests.

In basic research the Center maintains a high degree of competence in fields such as heat transfer, fluid mechanics, chemical kinetics, solid state physics and magnetism.

B. FACILITIES

The Lewis Research Center occupies two sites; one of 350 acres in the southwest corner of Cleveland, Ohio and one of 8,000 acres near Sandusky, Ohio (fig. 1).

The Cleveland site is located adjacent to the Cleveland Hopkins International Airport. It is bounded on the north by a mobile home park making up Riveredge Township, the smallest municipality in Ohio. On the west it abuts the Rocky River Reservation of the Cleveland Metropolitan Park System and on the south a residential area.

The Plum Brook site is surrounded by farm lands and low density housing.

Investment in facilities at Lewis now totals approximately \$340 million. The major facilities at the Cleveland site (fig. 2) include two large supersonic wind tunnels, a Propulsion Sciences Laboratory, Engine Research Building, Rocket Engine Test Facility, Zero-Gravity Facility and Electric Propulsion Laboratory. In all there are about 150 buildings on the site.

At Plum Brook Station (fig. 3) there are about 100 buildings ranging in size from small pump houses to the large Space Power Facility. Other major facilities include the Nuclear Reactor Facility, Space Propulsion Research Facility and the Hypersonic Wind Tunnel.

1. Cleveland Facilities

Wind Tunnels - The 8 x 6-foot wind tunnel is capable of producing air speeds in the transonic range, between Mach 2 and 3.5 (up to 2311 mph) at altitudes as high as 150,000 feet. These tunnels currently are being used for jet engine research, such as evaluating advanced types of inlets before they are flown. A separate section of the 8 x 6-foot tunnel provides an additional capability for testing propulsion concepts for vertical or short take-off and landing type aircraft.

Propulsion Systems Laboratory - Large jet engine systems and components can be tested in the altitude chambers housed in PSL. The chambers are capable of producing the varied altitude and temperature conditions of flight, and handling the hot exhaust gases of engines.

Engine Research Building - A variety of research projects is carried out in ERB's numerous test cells. Work is done on magneto-hydrodynamic and Brayton Cycle power conversion systems, flexible solar cell arrays, jet engine rotating components and combustor build-up, to name only a few.

Zero-Gravity Research Facility - Lewis' Zero-G facility, a 430-foot drop tower, is employed to study fluid behavior under weightless conditions ranging from five to ten seconds. Zero-gravity studies have

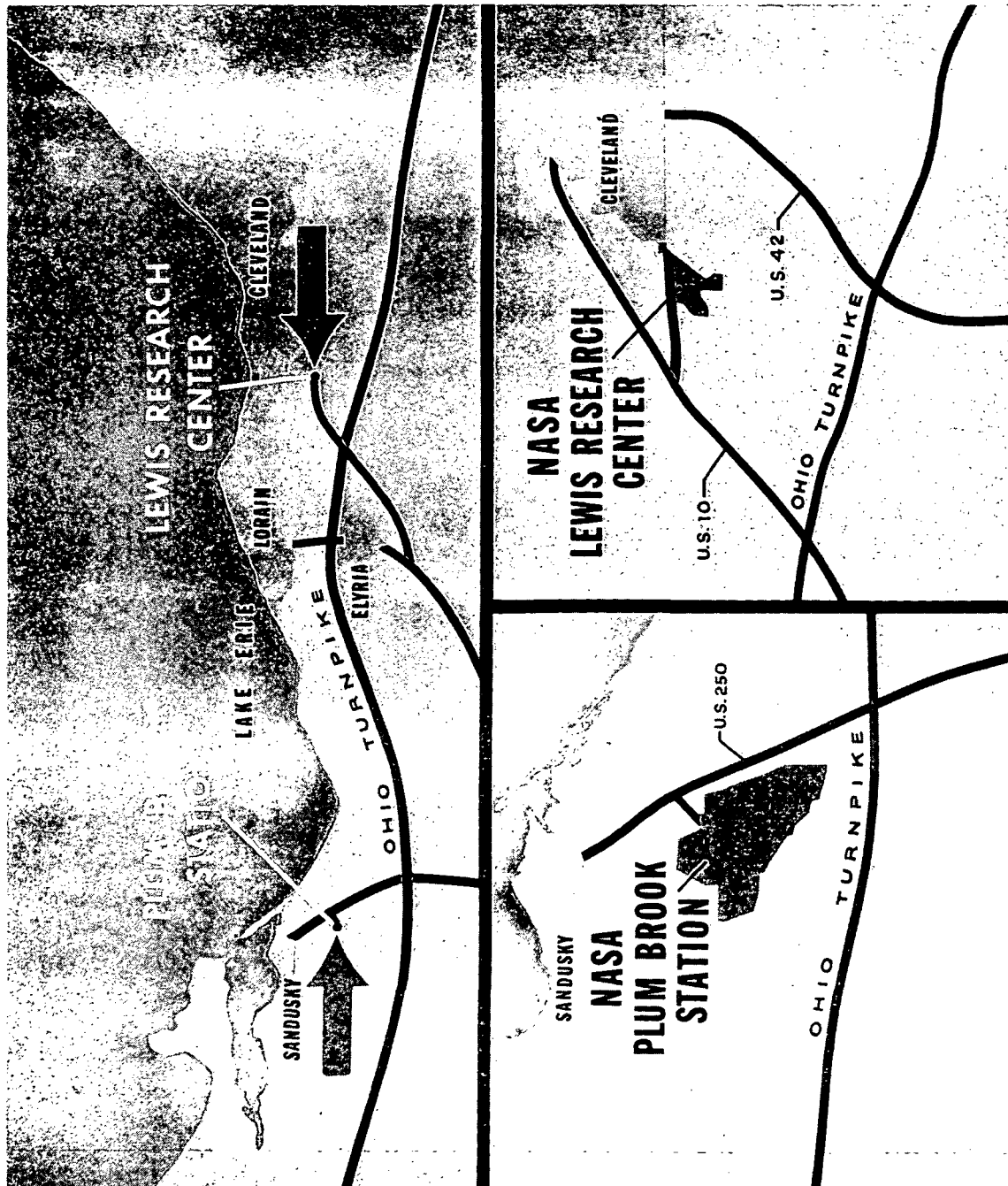


Fig. 1

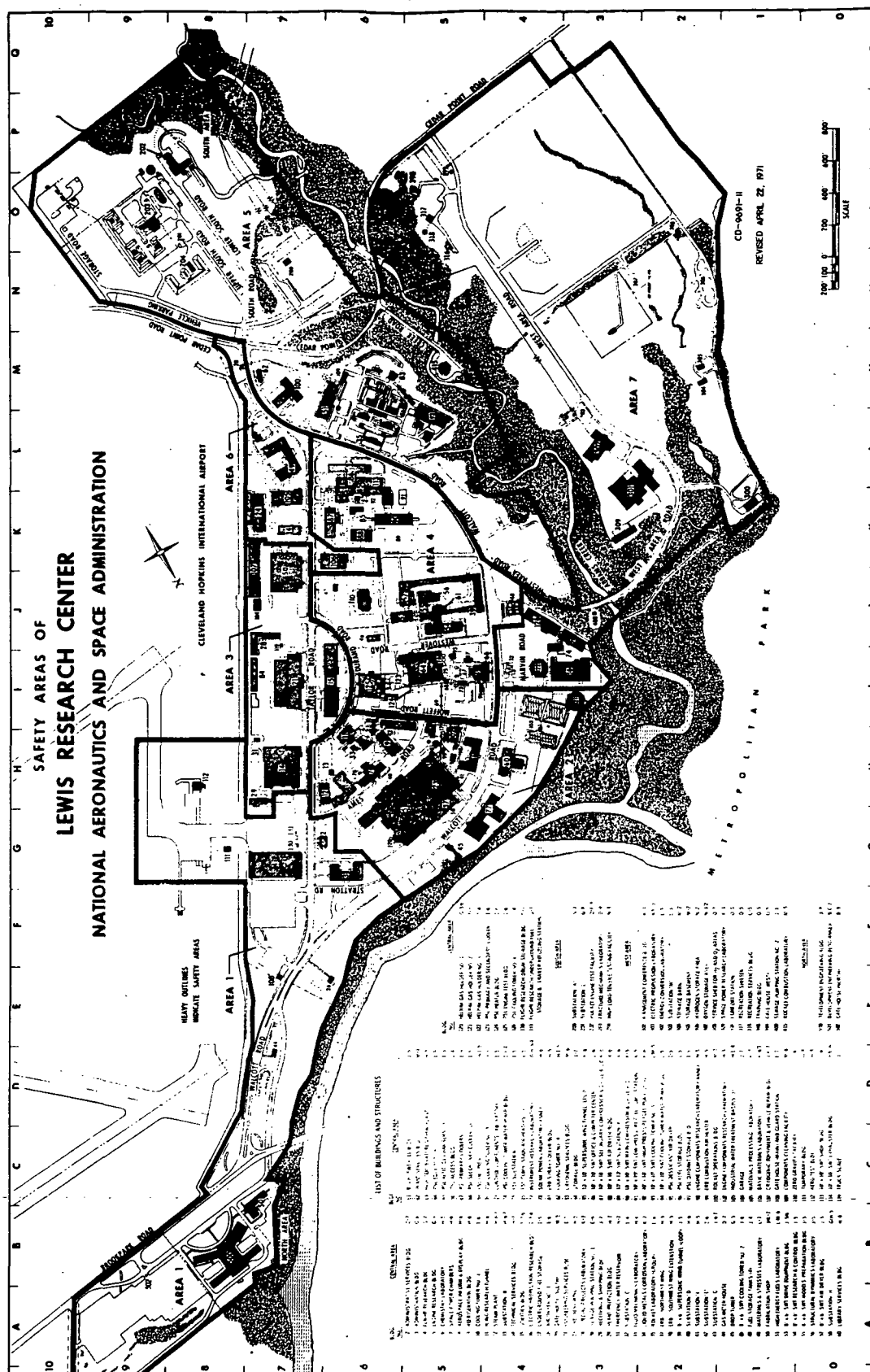


Fig. 2

helped in the design of effective propellant management systems for rockets that must re-start in space, for example.

Electric Propulsion Laboratory - Two large space tanks in EPL furnish the necessary space environment for research to be conducted on advanced electric propulsion systems such as ion engines. Vacuum conditions at altitudes up to 300 miles can be achieved in the larger chamber, 70-feet long by 25-feet in diameter.

2. Plum Brook Facilities

Space Power Facility - The largest deep space chamber at Lewis and perhaps in the world is contained in Plum Brook's Space Power Facility. The 100 x 120-foot chamber provides a simulated space environment for testing large propulsion and space power systems, including those with nuclear heat sources. Endurance tests of the Brayton Cycle power conversion system and shroud separation tests for Skylab have been made since the facility was completed in 1970.

Nuclear Test Reactor (PBRF) - The 60-megawatt test reactor located at Plum Brook is an important tool for evaluating materials and components which may be used in nuclear systems. Irradiation experiments are pertinent to nuclear propulsion, nuclear space power, energy conversion, basic radiation effects, and basic nuclear physics. The Reactor Facility contains a hot lab with remote handling equipment to evaluate and disassemble irradiated material.

Spacecraft Propulsion Research Facility - Rocket stages such as the hydrogen-fueled Centaur and full scale spacecraft can be tested under space vacuum and thermal conditions in the SPRF. This new facility permits actual hot firing of rocket engines at altitude for as long as 380 seconds.

Hypersonic Tunnel Facility - Presently under construction at Plum Brook, the Hypersonic Tunnel is designed to support research on inlets, supersonic combustion, nozzles and cooling of engines operating in the Mach 5 to Mach 7 range. Free jet testing of ramjet engines up to two feet in diameter will be possible in this facility.

II. PROBABLE ENVIRONMENTAL IMPACT

Operations at the Lewis Research Center have a negligible adverse effect on the environment. The outlook for the future indicates that this condition will prevail.

At the Lewis Cleveland site the attempt has been made to combine a modern research facility with the natural beauty of the Rocky River valley which it borders. Landscaping is accented by many informal flower beds and Japanese crabapple tree varieties. In late 1969, the Center was recognized as first in landscaping beauty among large industrial complexes in the area by the Garden Center of Greater Cleveland and the Greater Cleveland Growth Association.

The absence of harmful environmental impact from the Cleveland site operation is apparent. The Rocky River Reservation of the Metropolitan Park System abutting the site on the west is a flourishing green belt abounding in wildlife and used and enjoyed by tens of thousands of people as a recreational area the year round.

The Lewis Plum Brook Station has conducted an environmental monitoring program for the past 10 years to measure the level of radioactivity in the environs. Continuously operating air samplers are installed in nine locations on station and at six significant centers of population within a 9-mile radius. Samples of air, water, precipitation, fall-out, vegetation, milk, and fish are obtained and analyzed. This provides a continuing record of the radiation environment near PBRF, establishes trends, and identifies potential problems. These data have consistently shown the effectiveness of the PBRF effluent controls.

The Lewis Plum Brook Station near Sandusky protects approximately 700 deer on more than 5000 acres. Also, during the past several years, Plum Brook Station has engaged with State and Federal agencies in cooperative programs designed to study and preserve wildlife. For example, laboratory space is provided on an interim basis, and land in a buffer zone area on a long term basis, to the Dept. of Interior for studies of blackbirds and fish.

III. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS

A. AIR POLLUTION

The chart below summarizes the potential sources of air pollution at Lewis together with the nature of techniques for control.

POTENTIAL AIR POLLUTION SOURCES AND ABATEMENT PROCESSES -- CLEVELAND AND PLUM BROOK SITES

Type Facility	Operation	Frequency	Potential Air Contaminators	Control Group	Control Technique	Treatment Process	Means for Discharge to Atmosphere
Rocket and Jet Engine Testing	Engine Firing	Intermittant	Hydrocarbon Fuel Exhaust	Rocket System & Test Installation	Periodic Sampling	Water Spray Scrubber	High Velocity Exhaust Stack
Cryogenic & Inert Gas Storage	Storage	Continuous	(Non-contaminating) - H ₂ , O ₂ , He, A, N ₂	Facilities Operation	None	None required (Negligible Quantity Vented)	Vented through Relief Valves
Hazardous Gases and Liquid Storage	Storage	Continuous	(Toxic) Cl, F, N ₂ O ₄ , NH ₃ , Hydrazine	Facilities Operation/Safety	Detection Devices	Spray and Deluge System	None - Closed Systems
Liquid and Gas Fuel Storage	Storage	Continuous	(Non-contaminating) - H ₂ and Hydrocarbon	Facilities Operation	Safety Detection Device	None	Vent Stacks
Cooling Towers	Cooling Water Evaporation & Drift	Continuous	None	Plant Services	None	None Required	Vertical Exhaust Fan
Wind Tunnel Exhaust	Test Section and Seal Evacuation	Intermittant	Lubricating Oil Carryover	Test Installation	Periodic Sampling Exhaust	Water Spray Scrubber	High Velocity Exhaust Stack
Nuclear Reactor	Research Testing	Intermittant	Radioactive Isotopes	Reactor Operation and AEC	Sampling and Detection	Filters; Accumulator Tanks	High Velocity Exhaust Stack
Chemistry Research Laboratories	Research Testing	Intermittant	Miscellaneous Fumes; Gases	Laboratory Technical Operation	Visual and Detection Devices	None (Negligible Quantity)	Roof Exhaust Fan
Carpenter Shop	Wood Planing; Milling/Painting	Intermittant	Sawdust/Paint Fumes	Facilities Operation	Visual	Cyclone Separator Exhaust System	Roof Exhaust Fan
Welding Shop	Fabrication	Intermittant	Welding Fumes	Fabrication	Visual	None (Negligible Quantity)	Exhaust Fan
Boiler Plant	Steam	Continuous	Coal-Oil-Natural Gas Smoke; Flyash	Plant Operations	Visual	Combustion Air Adjustment; Flyash Cyclone Separator on Stack and Ash Handling	Chimney Stack

1. The Altitude Exhaust System provides altitude simulation and exhaust to atmospheres for testing engine components and complete propulsion systems. Altitude exhaust conditions are provided at the Engine Research Complex and the Propulsion Systems Laboratory (PSL) by the use of Roots-Connersville and DeLaval exhausters. The total exhaust system is capable of handling up to 1,260,000 pounds per hour of combustion air and the exhaust products of combustion from burning 90,000 pounds of fuel per hour.

The combustion gases pass through spray scrubbers and then discharge to the atmosphere through the DeLaval Exhaust stack, Atmospheric Discharge stack and the PSL ejector and main stacks. Typical effluents from these stacks are products of hydrocarbon combustion such as unburned fuels and lubricants, carbon dioxide, carbon monoxide, nitrogen dioxide, and aldehydes.

Control over exhaust emissions from these stacks can be exerted by limiting running time, running only under certain wind and weather conditions, using dilution and ejection, restricting which stack can be used, and shutdown of operations. Monitoring and consulting for these stacks is done by the Chemical Services Unit of the Safety and Project Planning Office.

There have been complaints about malodorous effluents from these stacks by personnel in areas adjacent to the Engine Research Complex. These complaints are mostly of nuisance and discomfort for limited periods with no known physiological effects. Odor complaints are referred to a special investigating committee which evaluates the degree of nuisance or health problem at the site. Test operations are stopped temporarily, if the committee deems it necessary for reasons of safety or health.

In an effort to more readily disperse the stack exhaust gases to the atmosphere and alleviate the odor problem an eleven (11) foot extension was added to the DeLaval Exhaust stack in February 1971.

The maximum height of stacks in the Engine Research area are limited because of the air traffic flight path to Cleveland Hopkins Airport. Funds for exhaust stack modification of scrubbers for hydrocarbon odors were submitted in the LeRC FY 72 C of F request.

2. Rocket engine testing is conducted at the Rocket Engine Test Facility and the Propulsion Systems Laboratory. The exhaust products from the combustion of such rocket fuels as hydrogen-oxygen, hydrogen-fluorine, hydrazene-nitrogen tetroxide are thoroughly scrubbed with either water or caustic solution before being released to the atmosphere through exhaust stacks. Other than occasional accidental releases of nitrogen-tetroxide and hydrogen-fluorine for short durations, the exhaust scrubbing systems have provided very effective control on emissions.

3. The Steam Generating Plant is operated under contract that requires that the contractor must comply with the provisions of the City of Cleveland Code. As a measure to upgrade the facility, new combination gas and oil burners were installed in No. 4 boiler (35,000 pounds per hour) and in No. 5 boiler (70,000 pounds per hour). Both boilers can burn No. 2 fuel oil which has a sulfur content of 1/2 percent. At present, these boilers are operating with natural gas. No. 3 boiler (15,000 pounds per hour) which burns only natural gas is also in use. Coal boilers No. 1 and No. 2 (each 35,000 pounds per hour) are shut down and will only be used in case of emergency. Funds for oil storage tanks for an alternate fuel source were submitted in the LeRC FY 72 C of F request.

B. WATER POLLUTION

It is the policy of the Lewis Research Center to accomplish as much removal and treatment of industrial wastes as possible at the source. All buildings, laboratories, and test cells discharge their industrial wastes and spills to basins or tanks in the immediate vicinity of the activity. The wastes in these basins are checked for possible contami-

nators, pH, dissolved oxygen, toxicity, and other parameters (depending upon the type of waste involved). Necessary treatment with chemicals is then initiated prior to discharging the batch into the industrial waste sewer system which has been installed to collect these wastes from the various research and testing operations.

1. Cleveland Site

a. In general, activities which utilize cryogenic rocket propellants do not produce a water pollution hazard. The exception is liquid fluorine which requires special treatment of the scrubber water. Treatment of these fluorine-based wastes consists of filtration through a limestone filter and dilution.

b. The four major cooling tower systems and their water inventory is as follows: ERB, 1 million gallons; 8x6 SWT, 87,000 gallons; PSL, 1.75 million gallons; 10x10 SWT, 1 million gallons. No phosphate or chromate inhibitors are used in the water that is recirculated through the systems. When required, cooling tower water is drained into the industrial waste basin following a certification analysis of the water.

c. Oil separators are located in the vicinity of the various test cells or buildings. All industrial waste waters pass through these. The separators are pumped out as required by an outside contractor.

d. All industrial wastes pass into a special industrial waste sewer system and are collected in two concrete-lined, one-million gallon retention basins, operated alternately. After a basin becomes full, the contents are analyzed to insure that contaminated concentrations are within allowable limits and then discharged into the Rocky River. No treatment other than dilution, detention, and settling is accomplished in the retention basins. Treatment at this point is not normally required. However, waste waters in the basin which have metallic concentrations greater than the allowable limit can be pumped into the sanitary sewer system for dilution and further treatment. Funds for a skimming and neutralization system to up-grade the industrial waste retention system were requested in the LeRC FY 72 C of F programs.

e. All sanitary wastes receive secondary treatment, either by the City of Cleveland or by a small package treatment plant. The package treatment plant serves a maximum of 10 of the 3800 employees at the site.

f. There is a problem with a City of Cleveland storm sewer that runs through NASA property. An industry located at the Airport has been continuing to dump sanitary sewage and oil separator pit overflow into the storm sewer. The City of Cleveland has been informed of the problem and should take corrective action.

g. Based on water samples taken from the industrial waste basin outfall by the FWQA Lake Erie Basin Office on July 20-21, 1970, the Lewis Research Center was included on a list of 50 leading mercury polluters issued by the Dept. of Interior, Sept. 16, 1970. To ascertain the validity of the charge and the remedial steps needed if the charge was correct, a complete investigation was undertaken. It was found that the sampling procedure employed by the FWQA Lake Erie Basin Office was incomplete, in that no sample of the tap water was made to determine the amount of mercury in the incoming water. Follow-on analyses performed by the U. S. Geological Survey Laboratory, Denver, Colorado, FWQA laboratories and Lewis revealed no difference in the mercury concentration between incoming tap water and outgoing industrial basin/storm sewer water, i.e., no mercury discharge from the NASA-Lewis installation. To date daily samples continue to show no significant difference on mercury content between incoming and outgoing water.

2. Plum Brook Station

Wastes generated by the Plum Brook Station include domestic sanitary sewage, industrial wastes, and radioactive wastes. Sewer systems have been installed in the Reactor Area in the north portion of the site, and in the Administrative Area in the northeast segment. However, because of the distances separating most of the areas on the site, no general sewer systems have been installed to collect and transport wastes to a single point.

a. A septic tank system serves the de-centralized test areas in the central portion of the site. These appear to be providing satisfactory treatment, and should continue to do so for these uses provided they are properly maintained so that their effluents do not reach any receiving stream. The main sewage treatment plant northeast of the site provides primary and secondary treatment. Chlorination facilities are also presently being operated.

b. The principal industrial waste generated is process and cooling water. The water from PBRF, under normal operating conditions, contains safe levels of alkalies, acids, dissolved solids, chlorides and other trace elements. Process and cooling water effluents are analyzed daily for 15 physical and chemical characteristics to ensure they are maintained below Federal and State standards.

c. Grease and oil from vehicle and equipment maintenance operations are collected in a holding tank at the 'Combined Shop' located in the central portion of the site. This tank is also pumped out periodically by private contractors. Cleaning agents used in the 'Combined Shop' are discharged to a bed of limestone, where they are neutralized and discharged to the sanitary sewer system.

C. RADIOACTIVE WASTES

The disposal of radioactive wastes is regulated by AEC licensing and law.

1. Radioactive liquid wastes at the Plum Brook Reactor Facility are collected via a hot drain system to underground tanks. After filtering and other treatment, analyses of a representative sample determine the dilution required to bring the concentration to within AEC limits. The tank contents are then released with diluent to Plum Brook. Concurrent with the release, the effluent is continuously monitored and automatically terminated if the concentration exceeds limits. Also a proportionate 24-hour composite sample of the total effluent is analyzed

daily for radiological, physical, and chemical characteristics. At Cleveland all potentially contaminated liquids discharge to hold tanks and are released to the sanitary sewer system after analysis shows they are within limits.

2. Radioactive gaseous wastes at PBRF are vented to a 100-foot stack following high efficiency filtering and continuous monitoring. The ventilation discharge of all potentially contaminated work areas, the operating equipment vents, and the experiment vent lines all discharge to the stack. However, the ventilation air from the reactor containment vessel, after filtering, is first pumped to hold tanks for monitoring prior to release to the stack.

A 246-foot exhaust stack has been built at the new Space Power Facility. All air from the test portion of the facility will be exhausted through this stack after passing through a filter system. The height of the stack will insure dilution and minimize the possibility of inversion of exhaust air. Air monitors will be located in the exhaust stack and at other remote points around the facility to detect changes in the level of radioactivity. In the event that the level exceeds the prescribed maximum, the test chamber will be sealed and the exhaust stack closed to prevent the discharge of additional air into the atmosphere.

In Cleveland, the Zero Power Reactor discharge is continuously monitored.

3. Solid radioactive waste is monitored, packaged in DOT and AEC approved containers, and disposed by contractor by land burial. Both PBRF and Cleveland facilities use this method of disposal.

D. HAZARDOUS WASTE STORAGE AND DISPOSAL

As a first course of action, hazardous materials are disposed of by contract provided that they can be transported safely and that the contractors disposal techniques meet air/water pollution standards.

An example was the disposal of approximately 2000 pounds of liquid metal by a contractor using a state licensed site in Kentucky.

Those materials not suitable for contractor disposal must be disposed of on-site. These include contaminated research hardware and materials in damaged spent containers or those with unknown specifications. However, present on-site storage and disposal are inadequate to meet the diverse hazard material problems inherent in the large research operation conducted at Lewis.

Proper requirements for storage and disposal of hazardous materials have been defined and a preliminary facility design made. Funds for a disposal handling facility were submitted in the LeRC FY 72 C of F request.

E. NOISE

Within the broad definition of protection of the quality of the environment, the control and abatement of noise has developed as a significant problem. The noise limits which are used as guidelines at Lewis are the ACGIH-1969; NHB 1840.1; and Chapter 4, Part B of the Lewis Operational Safety Manual.

Where high noise level equipment or rigs are to be operated, various techniques of noise attenuation have been utilized. Examples of some of these are the acoustic chamber at the 8x6 Wind Tunnel, attenuating boxes at shaker rigs in IRL, mufflers on the ERB/ECRL high velocity discharge air outlets, acoustic panels at the 10x10 Quiet Fan Program and the noise control curtain around the hydraulic pump in SPL.

Monitoring is performed both on-site and off-site depending on the nature and conditions of the runs. Complaints are dealt with immediately and in the rare instances where the noise cannot be attenuated, as in the case of establishing a base noise level for certain jet engines, the hours of operation are designed so as not to interfere with normal sleeping times.

Where there are engineering limitations to facilities or program requirements necessitating high noise levels in the facility operating area, the area is restricted to limited access during runs. Personnel in the area are required to wear ear protection. Some areas so designated are the PSL Equipment Building, ERB Cell SE-13, 10x10 Augmented Wing Program, SPF(PB) Exhauster Building.

IV. ALTERNATIVES

The Lewis Research Center is the lead center for research and development of aeronautic/space propulsion and electric power generation and as such is a vital part of the national scientific and technical effort. There are no appropriate alternatives to the operation of the LeRC at the present locations if the mission of the Center is to be accomplished, and there are no known reasons why the quality of the environment locally, statewide or nationally would improve if the facilities and operation were moved to another location. Further, the duplication of the facilities elsewhere would require the expenditure of \$340,000,000 and result in several years loss of operation.

V. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The local short-term use of the environment in the LeRC operation contributes to the enhancement of long-term productivity because of the scientific and technical knowledge that accrues.

Additionally, several important programs at LeRC are directly related to enhancing the quality of the environment. These are described briefly below.

1. Community noise pollution is a potential limiting factor in the development of the civil air transport system. A major research program is directed at understanding the aircraft engine noise generation and transmission mechanisms. Such an understanding will be used to develop ideas for reduced noise output propulsion systems. This work is closely related to FAA's interest in noise certification of future aircraft.

2. Extensive work on noise suppression is underway for turbofan engines of a size and type useful in commercial aircraft. Jet noise is reduced by engine design to lower the jet velocity. Detailed design of fan blades, slots in the casing at the fan-blade tips, and acoustic baffles and liners in the engine inlet provide engineering approaches to noise reduction. A \$22 million contract with the General Electric Company calls for demonstration turbofan engines incorporating the various engineering principles for noise reduction.

3. A major liability in aircraft currently considered for vertical or short take-off and landing operations is that they are inherently noisy. If such aircraft are to be useful in and around our growing urban complexes, they must be quieter. The Center is currently engaged in a variety of engineering experiments to establish engineering design principles for noise reduction from lift-fan and other propulsion systems. A contract is planned with a major engine manufacturer to demonstrate some of these principles in a lift-fan system. The Center is also examining a variety of other cycles with a view to optimizing among various performance parameters such as noise, safety, hover time, speed and range.

4. The concentrations of various particulate and gaseous pollutants in the region of the atmosphere between 20,000 and 40,000 feet will be measured by employing sampling devices on commercial air transports and special high altitude aircraft. These measurements will be used to establish baseline data on the contaminants in the atmosphere in order to deduce the relative contribution to atmospheric pollution by jet aircraft. This information may then be used to determine any necessary steps required to reduce pollution by jet aircraft.

5. Various techniques for reducing aircraft engine pollutant emissions will be investigated in full-scale primary combustors, full-scale reheat burners, and in various combustor segment rigs. A contract program will be conducted to apply the results to a combustor which can fit into an existing commercial aircraft engine.

6. Studies are being carried out in the reduction of automotive engine exhaust through the use of non-catalytic or thermal reactors. Contract and in-house efforts are directed at reactor materials and kinetics of combustion.

7. In support of the City of Cleveland, Division of Air Pollution Control, the LeRC is engaged in a cooperative program to determine particulate pollutants (elements and compounds) concentration as a function of seasonal, topographical, meteorological and source conditions. Aircraft flights for sampling will be utilized to obtain three-dimensional mapping of particulates. Methods will be developed to identify sources by a tracer technique. In support of studies on pollutant emissions from aircraft turbine engines a study of ambient conditions at the Cleveland Hopkins Airport will be carried out.

8. A joint program is planned with the Water Quality Office of the Environmental Protection Agency to determine the usefulness of satellites in monitoring water quality in the Great Lakes. The first objective is to use satellites to relay by radio data from sensors immersed in the lakes. These sensors can measure temperature, turbidity, acidity, and some specific pollutants. A longer range objective is to use satellites for direct sensing of water quality. An additional application being considered is a Great Lakes ice evaluation and monitoring.

9. The LeRC will provide technical assistance to the Environmental Protection Agency - Air Pollution Control Office (EPA-APCO) in the conduct of its Advanced Automotive Power Systems Research and Development program. This program seeks to develop an alternate power system whose exhaust emissions are virtually pollution free. The technical assistance will be in the areas of planning, consultation, and evaluation. Mutually agreed upon technical management of certain industrial contracts and certain test programs will be delegated to LeRC.

10. The Lewis Center designed an underwater camera system for the use of the Environmental Protection Agency - Water Quality Office, Lake Erie Basin. The camera observes algae growth by one photograph an hour for ten days at a time. A motion picture, "Project Hypolimnion," C-274, was made by LeRC for EPA describing the study and presenting the results.

11. Analytical and experimental studies are being conducted to determine the fluid mechanics effects of turbulent diffusion on air and water pollution. An application of this work is the discharge of pollutants (including heat) into streams and tributaries of large lakes with varying crossflows. Another example is the prediction of pollutant discharges from stacks and aircraft into the atmosphere.

VI. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF NATURAL RESOURCES

The following is a list of natural resources irretrievably committed during the annual operation of the Lewis Research Center, FY 71 estimates:

1. Natural Gas - 572 million cubic feet
2. Oil - 100,000 gallons
3. Electricity - 271 million kw-hr (generated off-site by Cleveland Electric Illuminating Co.)
4. Helium - 20 million standard cu. ft.

VII. PROBLEMS AND OBJECTIONS RAISED BY OTHER FEDERAL, STATE, LOCAL AGENCIES AND PRIVATE ORGANIZATIONS AND INDIVIDUALS

No adverse comment has been received from Federal, State or Local agencies or from private organizations or individuals on the substantive aspects of the draft impact statement. The only response received was from the CEQ, as follows "This is an excellent statement of the facility, its program and operation, and the various aspects of its operation which affect the environment. It does not, however, address itself specifically and explicitly to the five points required of an impact statement. The detail is good and the statement well written. Consequently, a fairly brief summary covering the five points could be produced."

VIII. COMMUNITY LIAISONS REGARDING ENVIRONMENTAL MATTERS
(FEDERAL, STATE AND LOCAL)

Cleveland Site

Monthly summaries of Industrial Waste, Sanitary and Storm Water Analysis are submitted to the Environmental Protection Agency, Chicago Office and the State of Ohio Water Pollution Control Board.

Plum Brook Site

Sewage Treatment Waste Report and PBRF Liquid Effluent Analysis Summary are submitted to the Environmental Protection Agency, Chicago Office and the State of Ohio Water Pollution Control Board.

Contacts have been made with the following agencies.

ENVIRONMENTAL PROTECTION AGENCY

Air - Ronald J. VanMersbergen
Region 5
New P. O. Building, Rm. 712
433 W. Van Buren Street
Chicago, Illinois 60607

Water - Merrill Gamet
Great Lakes Region Office
33 East Congress Parkway
Chicago, Illinois 60605

George Harlow, Director
Lake Erie Basin Office
21929 Lorain Road
Fairview Park, Ohio 44126

CORP OF ENGINEERS

Col. Ray S. Hansen, District Engineer
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